AAR-100

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<u>**New Feature:**</u>

- **Research Report -** *Realistic Radio Communications in Pilot Simulator Training*

This project is part of an overall effort of the Federal Aviation Administration (FAA) to ensure that airplane simulator fidelity is commensurate with its current use for total training and evaluation of airline pilots in the flight simulator. To assess the efficacy of current radio communications simulation and to define the requirement and feasibility of simulating radio communications, research into radio communications simulation was initiated. This report summarizes the first-year effort, including 1) a multi-disciplinary literature review focusing on Advanced Qualification Program (AQP) and crew resource management/cockpit task management (CRM/CTM); 2) a survey of instructor/evaluators (IEs) to determine current practices and to assess their opinions regarding the impact of realistic radio communications on training effectiveness; and 3) a review of the enabling technologies that might support future automated simulation of realistic radio communications.

Simulators used for total training and evaluation of airline pilots must satisfy stringent criteria to assure their adequacy for training and checking maneuvers. Radio communications, however, are currently not a part of these criteria, despite their integral role in every aspect of the flight environment. Ideally, simulation of air traffic control (ATC) communications to own and other vehicles (the so-called *party line*) as well as company voice communications should:

- Be appropriate for the airspace and responsive to crew actions

- Reflect the demands of ATC-driven timing that does not take pilots' activities or workload into account

- Contain a meaningful party line that can be used for enhancing situation awareness

- Expose pilots to communication problems such as communication frequency congestion, blocked frequencies due to stuck microphones, or non-native English-speaking ATC.

The underlying premise of this research is that providing a realistic radio communications environment would have a significant impact on safety by enhancing both pilot training and evaluation. A realistic radio communications environment should provide pilots with opportunities to:

- Practice frequency monitoring as well as task and distraction management skills

- Enhance crew resource management skills

- Practice coordination with ATC during new procedures, such as landing on parallel runways which requires an additional controller

- Improve their ability to increase situation awareness from meaningful party line containing information on traffic and weather

- Ensure their currency in ATC communication procedures and phraseology

- Reinforce attention allocation and differentiation skills necessary to distinguish clearances for one's own airplane from clearances for other aircraft

- Receive more focused attention from the instructor/evaluator

- Avoid an impoverished training environment potentially leading to the development of tunnel vision

- Reduce the so-called "simulator mindset," which may interfere with transfer of pilot performance and behavior to and from the airplane.

Literature Review

A review of the relevant AQP and CRM literature underscores the importance of realistic scenarios, and that coordination with company and ATC is an integral part of both the AQP task list and CRM. Additionally, a number of Aviation Safety Reporting System (ASRS) reports, research investigations, and industry, military, and general aviation magazine articles show that radio communications directly or indirectly contribute to incidents and accidents. These reports underscore the need to train pilots to practice how to recognize and question inadequate or demanding ATC instructions such as last-minute runway changes. The need to practice correct phraseology, especially during emergencies or with non-native English-speaking ATC is also evident from these studies. The requirement for developing and evaluating CRM skills is repeatedly emphasized in these reports, skills that cannot be adequately trained or assessed if key elements of the CRM scenarios, such as radio communications, are absent.

Instructor/Evaluator Survey

The Instructor/Evaluator Survey polled 29 instructor/evaluators from 14 different airlines, all participating in AQP. All I/Es queried indicated simulating some ATC communications, especially in the terminal environment. For company communications, all but one of the I/Es reported simulating at least some of them, most frequently dispatch. With regard to the party line, only 38 percent provided any communications to or from other traffic, mainly on the surface. Only two of these provided terminal and en-route party line information. Most radio

communications are simulated by I/E role-play, with few exceptions. Five I/Es indicated using handouts or ACARS (Aircraft Communications Addressing and Reporting System) for Clearance Delivery, and over half reportedly use either printed or recorded (synthetic or natural voice) ATIS (Automatic Terminal Information Service).

Regarding workload in the simulator, I/Es reported that for full mission simulation training and evaluation events, radio communications simulation and managing the simulator systems each consume about 20 percent of their time and effort. At least half of their time and effort is spent observing. When training, they spend eight percent of their time/effort instructing, versus only two percent when evaluating. Most felt that I/E impersonation of communications to own airplane increases the instructor workload and "divides his attention."

On the other hand, most instructors indicated that the current method of simulating radio communications produces an unrealistically low communications load for pilots compared to the real world, especially with regard to company communications. One mentioned that I/E impersonation of radio communications even reduces the manual workload of pilots, because they normally do not need to redial a new frequency to communicate in the simulator. Also, the I/Es think that the presence of meaningful party line information would increase training effectiveness, by "teaching pilots to listen" and "enabling [I/Es] to assess CRM elements such as workload and distraction."

I/Es indicated that scenarios rely on radio communications simulation to effectively teach such skills as (new) ATC procedures, CRM, and situation awareness. One I/E alluded to the fact that I/E role-play may lead to uneven training and unfair evaluation, since effective radio communications simulation is "all relative to the creative ability of the instructor."

Although some I/Es were skeptical with respect to the success of automating radio communications and its effect on reducing workload, they nevertheless indicated that it would increase training effectiveness. Perhaps due to I/Es' skepticism regarding other kinds of communication automation, ACARS and ATIS received the highest rankings for the anticipated beneficial effect of automation on training effectiveness.

A typical training situation with the instructor/evaluator simultaneously managing the simulator systems, observing the flight crew, and simulating radio communications. Note the absence of headsets

Technology Review

The technology review included:

- United Airlines' Interactive Real Time Audio System (IRAS), also (and too dismissively) known as "Chatter Program"

- AE's Ground and Air Traffic Environment System (GATES)

- Personal Computer Commercial Off-The-Shelf Systems (PC COTS)

- Intelligent Systems

- Voice Generation and Recognition Technologies

Two systems specifically designed for commercial air carrier simulation use were identified: IRAS and GATES. IRAS is a United Airlines in-house development with very high operational realism. It is based on field recordings of actual radio communications on the appropriate routes and includes a meaningful party line. By dubbing ATC with the respective I/E voice, the I/E can intervene without the pilot trainee realizing it. It was eventually abandoned due to technical difficulties with trigger algorithms and the high cost of scenario and system integration. GATES is a simulator add-on offering a representation of visual and radio communications terminal traffic. It is fully integrated with aircraft movement and other simulation events. Realism is increased, according to anecdotal feedback from some users. It does not, however, provide any communications to or from own airplane.

Radio communications simulation applications at the lower end of the flight simulator market were also identified. The PC COTS flight simulator market clearly perceives a market value for including realistic radio communications add-ons. Flexibility and controllability vary greatly among products. The relevance of the party line and the ability to send messages to ATC is limited. Generally, these programs are limited to frequency chatter and very limited ATC directives to the simulated aircraft.

Enabling technologies that would support the advancement of realistic radio communications simulation include intelligent systems, and voice generation and recognition technologies. Intelligent systems have the potential for a high degree of communication realism with no instructor intervention; they use rule-based models of goals and behavior of speaker (e.g., controller). Messages are generated based on speaker task goals and situation awareness, thus eliminating the need for complex "triggering" algorithms or complex scenario scripting.

Finally, any successful radio communications simulation system would have to rely on speech generation and recognition systems. Great progress has been made in both fields. Both rule-based synthetic speech and digitized natural concatenated speech achieve intelligibility ratings rivaling natural speech, but voice quality is still an issue especially in a high-workload environment. The main problem for voice recognition system remains speaker variability; even with a highly regulated phraseology such as that used in aviation, extensive "training" of the system is required for reliable recognition of the utterances of a particular speaker.

Conclusions

The following findings are documented in the report:

- The literature emphasizes the need for a realistic training and evaluation environment.

- Subject matter experts perceive realistic radio communications as important.

- Airlines mostly leave the simulation of radio communications to the already very busy individual instructor/evaluators due to cost considerations.

- The technology to simulate ATC/Company and party line automatically is still immature, although there are some promising emerging technologies.

The underlying premise of this work—that the provision of realistic radio communications during training and evaluation of airline pilots would enhance safety—has been confirmed thus far. The airlines, however, are unlikely to commit the funds required for the provision of realistic radio communications in the absence of a documented gain in safety and an FAA requirement. The technology development seems to be largely market driven, but would of course be furthered by such a requirement. Therefore, a proof of concept is required that will empirically demonstrate the need for realistic radio communications.

A first step may be to systematically compare the communication load and its effect on pilot workload and CRM behaviors as a function of radio communications during actual operations in the air versus simulator Line Oriented Flight Training/Line Operational Evaluations (LOFT/LOEs). Another step may be an assessment of pilots who have just completed the initial qualification in their first fleet. The question of interest would be how prepared such pilots are to handle ATC and company communications requirements during their first Initial Operating Experience (IOE) flights. This may be followed up by a carefully conceived simulator study examining the benefits of different levels of radio communications realism for different training and event types. Full skill transfer to and from the airplane is a critical issue, if simulator use for training and evaluation is to be mandated. (Bürki-Cohen, J., Kendra, A.J., Kanki, B.G., Lee, A.T. (December 2000). Realistic Radio Communications in Pilot Simulator Training. Washington, DC: DOT/FAA/AR-00/13.) Available online: http://www.volpe.dot.gov/opsad/rrcrprt.html

Human Factors News Reports

- **FAA/NASA IAIPT Human Factors TIM Summary** - A summary of the FAA/NASA Interagency ATM IPT human factors technical interchange meeting (TIM) held February 5-6, 2002 in Washington, DC is now available on the IAIPT-HF web site: http://kms.faa.gov/iaipt-hf/ . The next planned joint activity involves an evaluation of human factors guidance that could be developed to assist in the understanding of and planning for transitioning enhanced capabilities through the Technology Readiness Levels. (P. Krois, AAR-100)

- **NEXCOM Latency Study -** Human factors researchers at the William J. Hughes Technical Center (ACB-220) concluded the NEXCOM Very High Frequency Digital Link Mode 3

(VDL3) Latency Study on April 5th. Controllers from ARTCCs nationwide participated in the simulation and evaluated alternative delays in the VDL3 communications system. The research team is analyzing the data and writing a Quick Look report. (R. Sollenberger, WJHTC).

- **Free Flight Human Factors: Traffic Management Advisor - Time-Based Metering Training Simulation -** The Traffic Management Advisor (TMA) is a flow control tool developed by NASA and the FAA to help the ARTCC traffic management coordinator (TMC) more efficiently schedule arrival traffic to the metering fixes for hand-off to the TRACON. TMA contains sophisticated methodology that facilitates the use of time-based metering (TBM), a method for managing periods of high arrival demand at airports that has been shown to provide terminal area capacity increases over the miles-in-trail (MIT) method of arrival flow control. Operational acceptance of TBM presents challenges in that it requires a change in operational thinking. A key component of the Free Flight Program Office's human factors approach for achieving controller acceptance of TBM is simulation training. Recently, a cadre of controllers from Atlanta (ZLA) and the Southern California TRACON (SCT) participated in a one-week training event designed to provide hands-on experience with TBM. The Free Flight Program Office and the Engineering and Integration Services Branch (ACT-250) conducted the training simulation March 13-21, 2002, at the William J. Hughes Technical Center DSR and ARTS high-fidelity laboratories. The ZLA cadre was provided training to better understand TMA system performance, develop skills for performing TBM, and to observe traffic flow in a TBM-based environment. SCT controllers were provided the opportunity to observe the flow of aircraft into SCT feeder sectors during TBM. The training they received will enable the cadre to begin training other controllers – setting the stage for a smooth transition to TBM at ZLA. (F. Johnson, AOZ-40)

- **Congressional Visit -** Human factors researchers at the William J. Hughes Technical Center briefed Senate staff members on the methods and projects that are conducted by the NAS Human Factors Group, ACB-220. They also conducted demonstrations of Research Development and Human Factors Laboratory capabilities, including rapid prototyping, human-in-the-loop simulation, and virtual reality modeling. (M. McAnulty, WJHTC)

- **Tower Cab Metrics:** Human factors researchers at the William J. Hughes Technical Center (ACB-220) completed a technical note entitled, "Tower Cab Metrics" (DOT/FAA/CT-TN02/03). This report reviews a number of existing sources of measures that have been used in different ATC environments and proposes a battery of objective and subjective measures for the Tower Cab environment. (R. Sollenberger, WJHTC).

- **Air-Ground Integration Experiment:** Human factors researchers at the William J. Hughes Technical Center (ACB-220) completed a technical note entitled, "Air-Ground Integration Experiment", (DOT/FAA/CT-TN02/06). This study was conducted as an inter-agency research effort between the FAA, NASA Ames Research Center, and the Volpe National Transportation Systems Center. The research investigated alternative shared-separation concepts in a real-time human-in-the-loop simulation involving both controllers and pilots (R. Sollenberger, WJHTC).

- **Operational Evolution Plan** - On April 10th, the first meeting was held at the William J. Hughes Technical Center to kick off the NAS 2010 effort associated with the FAA's Operational Evolution Plan. NAS 2010 is an integrated modeling and simulation activity to assess technology, procedures, and airspace changes scheduled for delivery in the OEP. The meeting's overall objective was to gain a common understanding of current modeling and simulation capabilities at NASA, MITRE CAASD, and FAA facilities including the Technical Center and CAMI. Representatives from these organizations attended, as well as FAA and NASA headquarters personnel. Significant lessons learned from the joint FAA/NASA air ground integration experiment and Y2K effort were also reviewed. The meeting objectives were achieved and the next step is to draft a research management plan and identify points of contact within each organization. (J. Rehmann, WJHTC)

- **AAR Website -** The new Office of Aviation Research (AAR) website is now up and running at http://research.faa.gov/aar. This newly designed site includes links to FAA Technical Reports, newsletters, technology press releases, and much more. (T. Kraus, AAR-200)

*More information on human factors research can be found at
the FAA Human Factors (AAR-100) web site:* http://www.hf.faa.gov

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 CALENDAR

April 14-15, 2002 – FAA General Aviation Forecast Conference, Wichita, KS
http://api.hq.faa.gov/Conference/welcome.htm

April 14-15, 2002 – FREE Flight Safety Boeing Maintenance Human Factors Awareness Training for Managers, Seattle, WA http/://www.fsbti.com

April 16, 2002 – Aviation Week and Space Technology 45th Aerospace Laurels, Smithsonian Air and Space Museum, Wash, DC

April 23-24, 2002 – FAA R,E&D Advisory Committee, Holiday Inn Rosslyn Westpark Hotel, Arlington, VA mailto:gloria.ctr.dunderman@faa.gov

April 23-25, 2002 – NBAA Leadership Conference, Nashville, TN http://www.nbaa.org/

April 29-May 2, 2002 – DoD HFE TAG, Clarion Hotel Bayview, San Diego, CA
http://dtica.dtic.mil/hftag

April 30-May 1, 2002 – First Threat and Error Management (TREM) Training Workshop, San Salvador, El Salvador mailto:dmaurino@icao.int

May 5-9, 2002 – 73rd Annual Scientific Meeting of the Aerospace Medical Association, Queen Elizabeth's Hotel, Montreal, Canada http://www.asma.org/

May 6-12, 2002 – International Aerospace Exhibition and Conference, Berlin Brandenburg International Airport, Berlin, Germany http://www.ila-berlin.com/

May 13-15, 2002 – World Mail & Express Conference and Exhibition, Hilton Hotel, Amsterdam, Netherlands http://www.triangle.eu.com/

May 19-21, 2002 - Air Courier Conference of America, The Wigwam Resort, Phoenix, AZ mailto:jmorris@aircour.org

May 20-22, 2002 – International Air Cargo Conference, Opryland Hotel, Nashville, TN http://www.iacc-expo.com/

May 20-22, 2002 – 11th Annual Phoenix International Aviation Symposium, The Phoenician Resort, Phoenix, AZ http://www.phxskyharbor.com/

May 28-30, 2002 – EBACE2002, Geneva, Switzerland http://www.ebace.com/

June 13-14, 2002 – Aviation Conference and Exposition, Oklahoma City, OK mailto:skymarket@aol.com

July 22-28, 2002 – Farnborough International, England http://www.farnborough,com/

August 27-30, 2002 – Measuring Behavior 2002, 4th International Conference on Methods and Techniques in Behavioral Research, University of Amsterdam, Amsterdam, The Netherlands http://www.noldus.com/events/mb2002/index.html

September 16-18, 2002 – Conference on Aerospace Materials, Processes and Environmental Technology, Huntsville, AL http://ampet.msfc.nasa.gov/

September 17-18, 2002 – FAA R,E&D Advisory Committee, Holiday Inn Rosslyn Westpark Hotel, Arlington, VA mailto:gloria.ctr.dunderman@faa.gov

September 17-20, 2002 – International Air Cargo Forum, Hong Kong http://tiaca.org/

September 30- October 4, 2002 – Human Factors and Ergonomics Society 46th Annual Meeting, Baltimore Waterfront Marriott Hotel, Baltimore, MD http://www.hfes.org/

October 14-16, 2002 – Third LOSA Week, Dubai, United Arab Emirates mailto:dmaurino@icao.int

October 23-25, 2002 – International Conference on Human-Computer Interaction in Aeronautics, Massachusetts Institute of Technology, Cambridge, MA http://www-eurisco.onecert.fr/events/hci-aero2002.html/

October 27-31, 2002 – 21st Digital Avionics Systems Conference, Hyatt Regency Hotel, Irvine, CA http://www.dasconline.org/

April 7-27, 2003 – Aviation World's Fair, Newport News/Williamsburg, VA http://www.worlds-fair.com/ or http://aviation-worlds-fair.com/

May 4-9, 2003 – 74th Annual Scientific Meeting of the Aerospace Medical Association, Convention Center, San Antonio, TX http://www.asma.org/

May 7-9, 2003 – EBACE 2003, Geneva, Switzerland http://www.ebace.com/

October 13-17, 2003 – Human Factors and Ergonomics Society 47th Annual Meeting, Adams Mark Denver Hotel, Denver, CO http://www.hfes.org/

May 2-7, 2004 – 75th Annual Scientific Meeting of the Aerospace Medical Association, Egan Convention Center, Anchorage, AK http://www.asma.org/

September 20-24, 2004 – Human Factors and Ergonomics Society 48th Annual Meeting, Sheraton New Orleans Hotel, New Orleans, LA http://www.hfes.org/

Note: Calendar events in Italics are new since the last Newsletter

Comments or questions regarding this newsletter?
Please contact Bill Berger at (334) 271-2928
or via e-mail at bill.ctr.berger @faa.gov